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(54) **PROCESSING CHANGED APPLICATION METADATA BASED ON RELEVANCE**

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G06F 9/44 (2006.01)
G06F 9/45 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 8/30*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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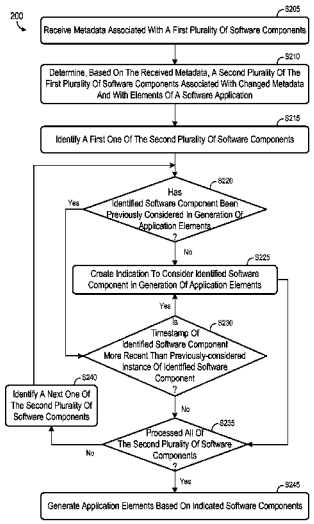
(57) **ABSTRACT**

A system includes execution of a software application based on metadata defining a first plurality of software components, reception of second metadata defining the first plurality of software components, determination, based on the second metadata, of a second plurality of the first plurality of software components for which the second metadata is different from the first metadata, and for which the second metadata is associated with elements of the software application, and generation of the elements of the software application based on the second metadata of the second plurality of software components.

9 Claims, 5 Drawing Sheets



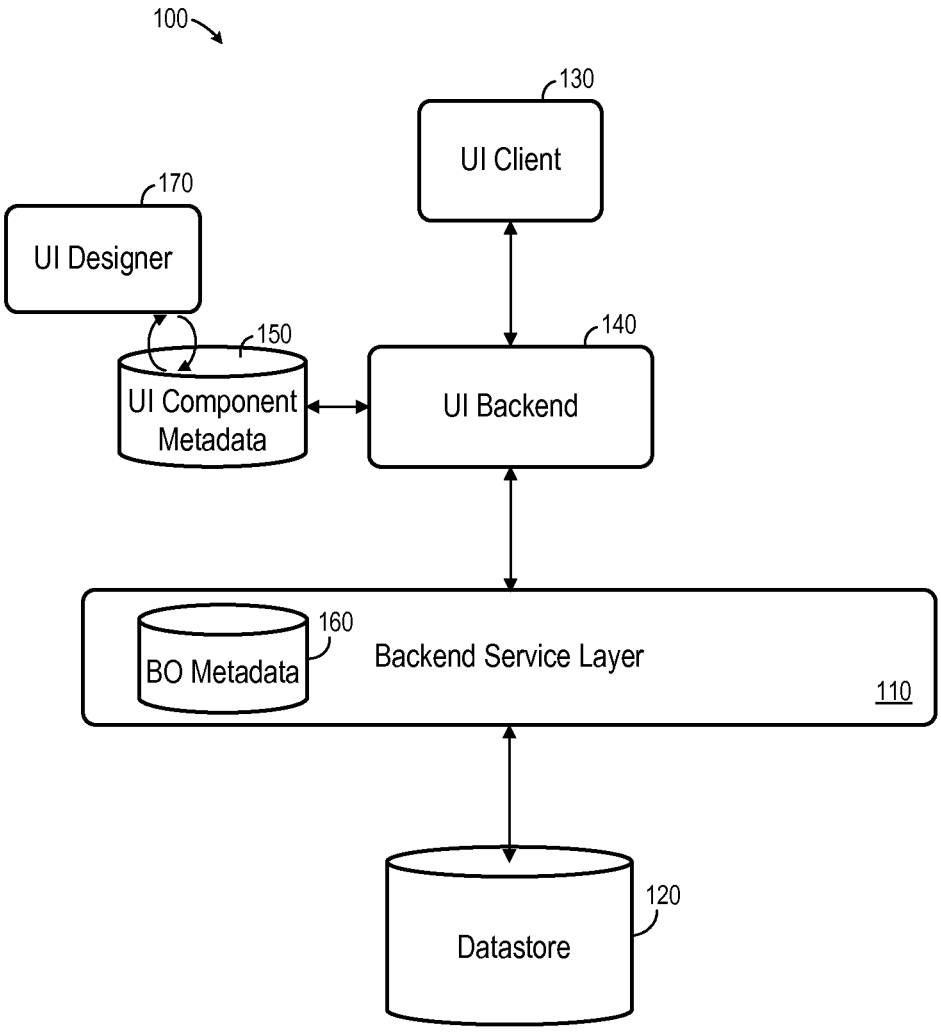

100
130
UI Client
170
UI Designer
150
UI Component Metadata
140
UI Backend
160
BO Metadata
Backend Service Layer
110
120
Datastore

FIG. 1

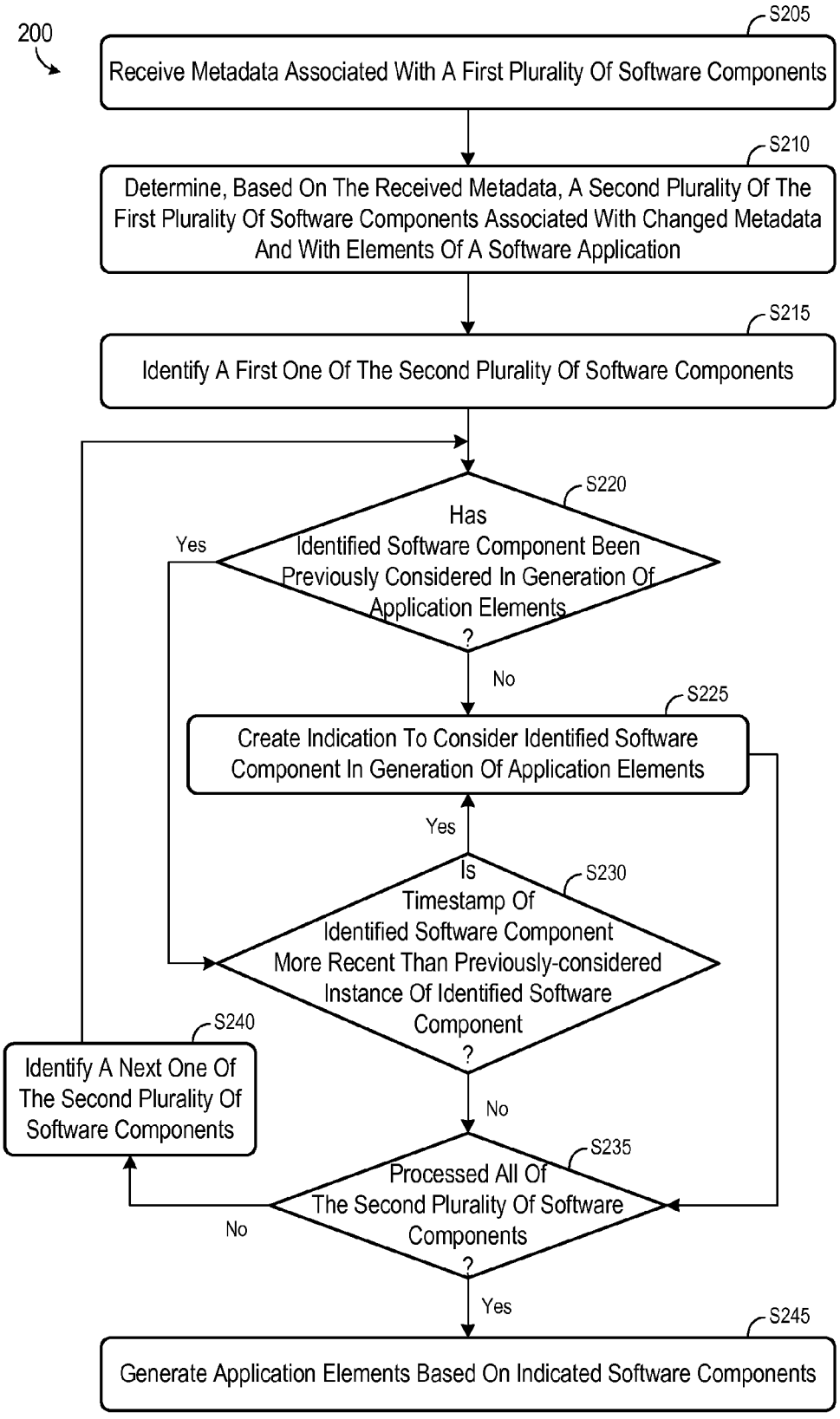

200
S205
Receive Metadata Associated With A First Plurality Of Software Components
S210
Determine, Based On The Received Metadata, A Second Plurality Of The First Plurality Of Software Components Associated With Changed Metadata And With Elements Of A Software Application
S215
Identify A First One Of The Second Plurality Of Software Components
S220
Has Identified Software Component Been Previously Considered In Generation Of Application Elements ?
Yes
No
S225
Create Indication To Consider Identified Software Component In Generation Of Application Elements
Yes
S230
Is Timestamp Of Identified Software Component More Recent Than Previously-considered Instance Of Identified Software Component ?
S240
Identify A Next One Of The Second Plurality Of Software Components
No
S235
Processed All Of The Second Plurality Of Software Components ?
No
Yes
S245
Generate Application Elements Based On Indicated Software Components

FIG. 2

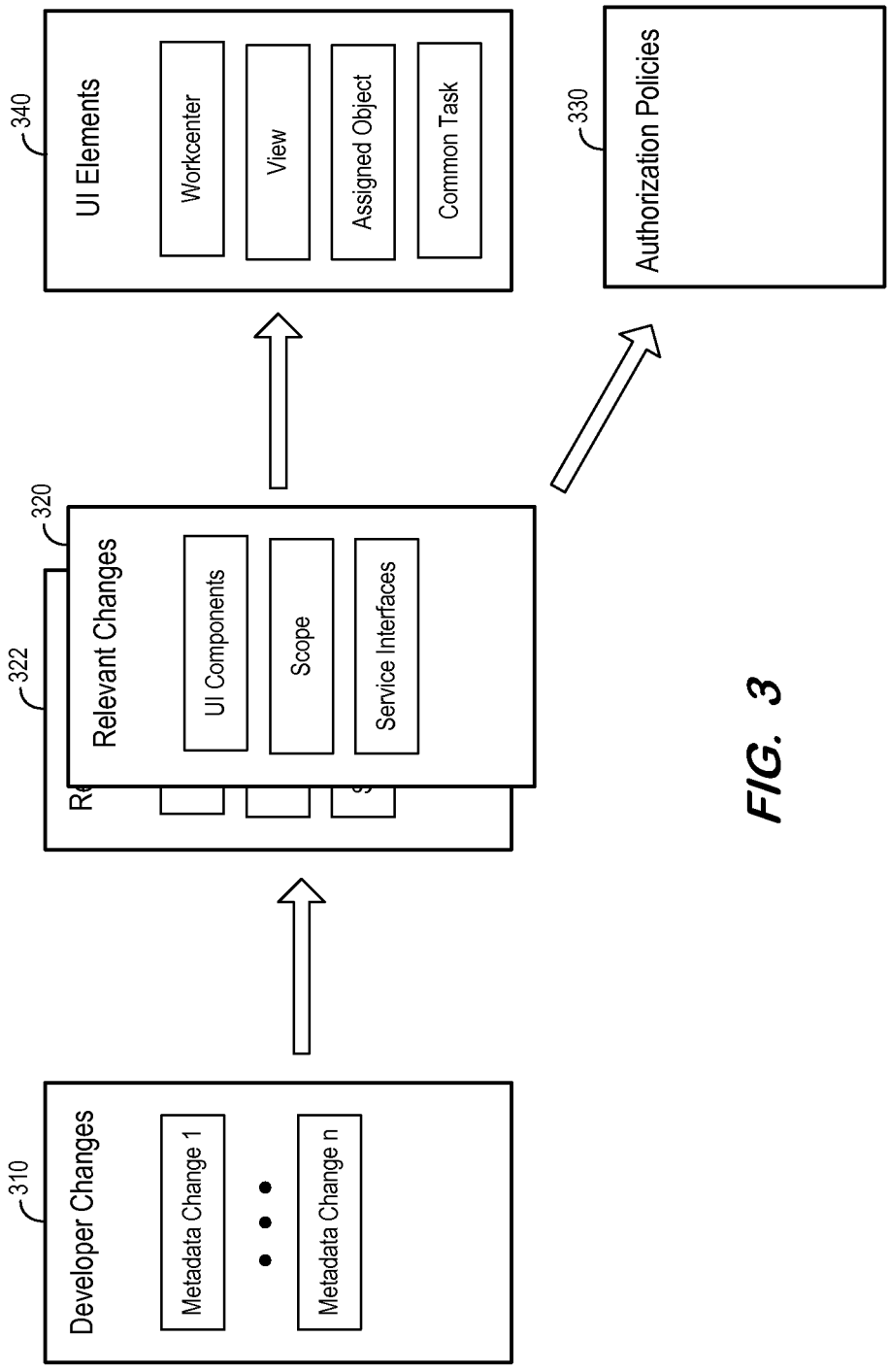

310
Developer Changes
Metadata Change 1
Metadata Change n
320
322
Relevant Changes
UI Components
Scope
Service Interfaces
340
UI Elements
Workcenter
View
Assigned Object
Common Task
330
Authorization Policies

FIG. 3

400

ShortName	Timestamp
comp001	010302011123323
comp007	010302011123445

FIG. 4A

400

ShortName	Timestamp
comp001	010302011123323
comp007	010302011123445
comp013	01102011093423

FIG. 4B

400

ShortName	Timestamp
comp001	010302011123323
comp007	01100201093554
comp013	01102011093423

FIG. 4C

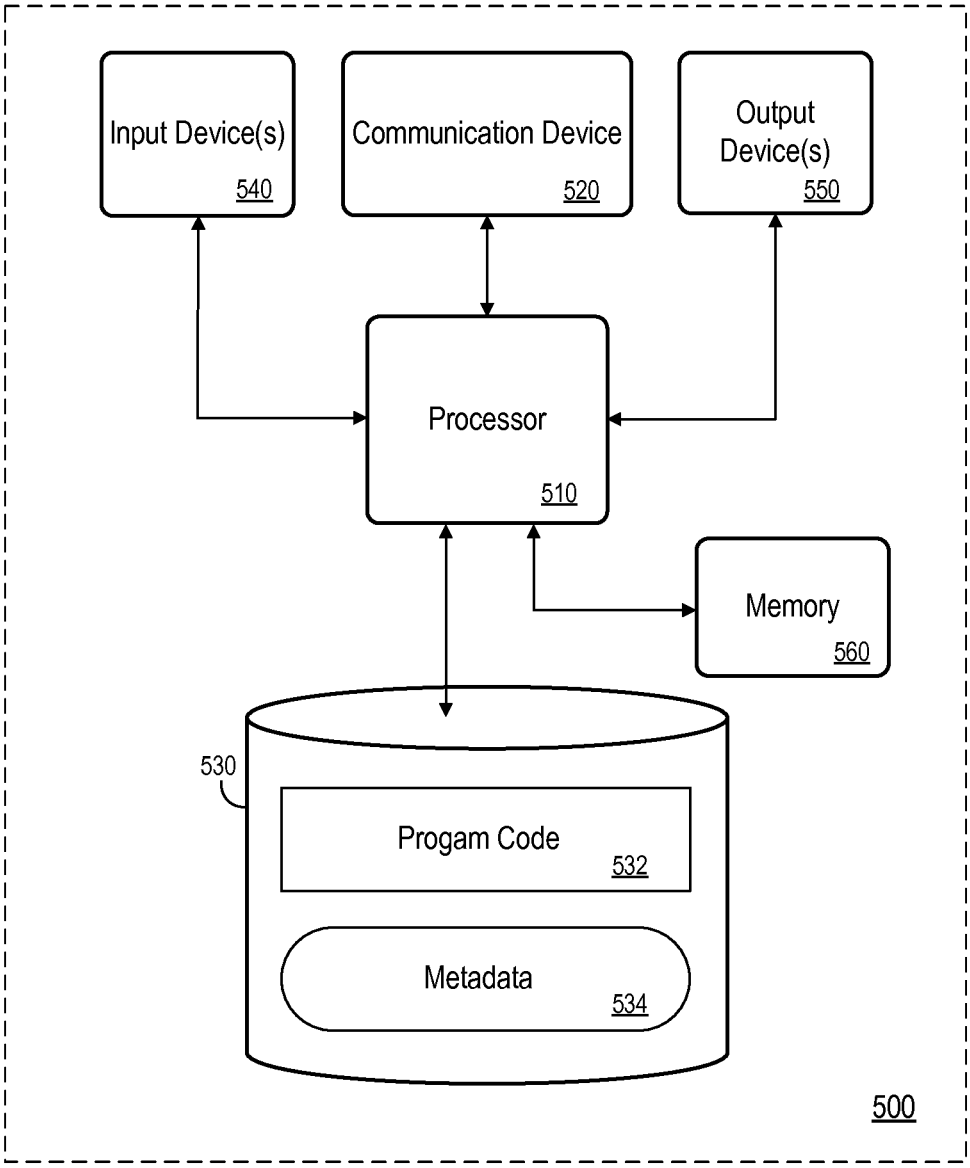

Input Device(s)
540
Communication Device
520
Output Device(s)
550
Processor
510
Memory
560
530
Progam Code
532
Metadata
534
500

FIG. 5

PROCESSING CHANGED APPLICATION METADATA BASED ON RELEVANCE

FIELD

Some embodiments relate to metadata-driven application platforms. More specifically, some embodiments relate to systems to effect imported metadata changes within a back-end service layer.

BACKGROUND

A backend service layer may implement metadata models to support different business solutions. Metadata models may include generic models of a business object, a floorplan (i.e., a user interface layout), user interface text, a process component, and a message type, among others. A business object, for example, is a software model representing real-world items used during the transaction of business. An instance of a business object metadata model may comprise a SalesOrder object model or an Organization object model. Instances of these object models, in turn, represent specific data (e.g., SalesOrder 4711, ACME corporation).

An instance of a business object metadata model (e.g., a SalesOrder object model or, more generically, a business object object model) may specify business logic and/or data having any suitable structure. The structure may be determined based on the requirements of a business scenario in which the instance is to be deployed. A business application for a particular business scenario may require many business object object models, where the structure of each has been determined based on the requirements of the particular business scenario.

A customer deploying a business application may desire changes to the business objects included in the business application. For example, a customer may require a field (e.g., "SerialNumber") which does not exist within the "Product" business object of a business application. A developer may therefore modify the metadata of the business object in the backend service layer to provide the additional field. A business application might also provide pre-defined user interfaces to interact with the business objects. A developer may similarly modify metadata of these user interfaces to add entities of a user interface data model and to bind these user interface data entities to business object entities.

The modified metadata must be imported by a backend service layer in order to take effect. Some systems provide a report which lists software components whose metadata has been modified. These software components may comprise business objects, user interface entities, etc., and the metadata modifications may affect certain elements of a software application which depend on the software components.

For example, according to role-based access management systems, a change pointer table lists any workcenters, workcenter views, floorplans, report usages and external user interface applications having changed metadata. Next, all workcenter views related to the changed UI entities are determined. Authorization policies are then regenerated for each determined workcenter view. However, some of the metadata modifications might not have any affect on authorization policies, so much of this policy regeneration might unnecessarily hamper runtime performance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system according to some embodiments.

FIG. **2** is a flow diagram of a process according to some embodiments.

FIG. **3** is a block diagram illustrating an example according to some embodiments.

FIGS. **4**A through **4**C are tabular representations of a data structure according to some embodiments.

FIG. **5** is a block diagram of a computing device according to some embodiments.

DETAILED DESCRIPTION

FIG. **1** is a detailed block diagram of system **100** according to some embodiments. System **100** includes backend service layer **110**, datastore **120**, user interface (UI) client **130**, UI backend **140**, UI component metadata **150**, business object metadata **160** and UI designer **170**. FIG. **1** represents a logical architecture for describing some embodiments, and actual implementations may include more or different components arranged in any manner. Some embodiments may also reflect architectures different from that shown in FIG. **1**.

Backend service layer **110** may comprise an enterprise services infrastructure and/or any implementation for providing services according to a service-oriented architecture paradigm. Backend service layer **110** may provide services to one or more service consumers. The services are provided by executing applications based on business object metadata **160**. According to the illustrated embodiment, the services may include retrieving, creating, modifying and/or deleting the data of business object instances stored in datastore **120**. Datastore **120** may comprise any one or more systems to store business data. Such systems include, but are not limited to, relational database systems, Online Analytical Processing (OLAP) database systems, data warehouses, application servers, and flat files.

To provide economies of scale, datastore **120** may include data of more than one customer (i.e., "tenant"). Backend service layer **110** includes mechanisms to ensure that a tenant accesses only the data that the tenant is authorized to access. Moreover, the data of datastore **120** may be indexed and/or selectively replicated in an index to allow fast retrieval thereof.

The data stored in datastore **120** may be received from disparate hardware and software systems, some of which are not interoperational with one another. The systems may comprise a back-end data environment employed in a business or industrial context. The data may be pushed to datastore **120** and/or provided in response to queries received therefrom.

UI designer **170** may be operated by a developer to design user interfaces by creating and modifying UI component metadata **150**. UI component metadata **150** may conform to a UI component model **150** which is suited to implementation of a user interface. The developer adds UI elements to screen layout patterns and binds the elements to entities of BO metadata **160**. This binding facilitates the transmission of data to and from backend service layer **110**.

UI client **130** comprises an application to render user interfaces defined by UI component metadata **150**. UI client **130** also receives user input (e.g., modification of data within a displayed field, selection of an item from a drop-down menu, selection of a checkbox, etc.) and, in response, transmits a corresponding UI request to UI backend **140**. UI client **130** may execute, for example, within a Web browser.

According to some embodiments, UI client **130** is located at a client or user site, while the other elements of system **100** are housed at a provider site and may provide services to other UI clients located at the same or another user site. The other elements need not always be accessible to UI client **130**. That is, UI client **130** may operate in an "offline" mode.

UI backend **140** provides communication between UI client **130** and backend service layer **110**. Generally, UI backend **140** receives a UI request which conforms to UI component metadata **150** from UI client **130**, communicates with backend service layer **110** to fulfill the request, and provides a response which conforms to UI component metadata **150** to UI client **130**. According to some embodiments, backend service layer **110** and UI backend **140** are components of a same physical computing device. Operation of UI backend **140** according to some embodiments will be described below.

FIG. **2** comprises a flow diagram of process **200** according to some embodiments. In some embodiments, one or more computing devices of an enterprise service provider execute program code to perform process **200**.

All processes mentioned herein may be embodied in processor-executable program code stored on one or more of non-transitory computer-readable media, such as a fixed disk, a floppy disk, a CD-ROM, a DVD-ROM, a Flash drive, and a magnetic tape. In some embodiments, hard-wired circuitry may be used in place of, or in combination with, program code for implementation of processes according to some embodiments. Embodiments are therefore not limited to any specific combination of hardware and software.

Process **200** may be performed at runtime to deploy metadata changes into an application platform such as that shown in FIG. **1**. In this regard, prior to process **200**, the application platform was executing a software application based on metadata defining a first plurality of software components (e.g., UI component metadata **150** and/or BO metadata **160**). Then, at S**205**, new metadata associated with the first plurality of software components is received. The received metadata may include the entirety of UI component metadata **150** and BO metadata **160**, or any subset thereof. Some or all of the received metadata defining particular software components may be identical to the prior metadata defining the particular software components, and based on which the application was executing.

FIG. **3** is a block diagram to illustrate execution of process **200** according to some embodiments. As shown, developer changes **310** include a plurality of metadata changes which are received at S**205**. Developer changes **310** may comprise, for example, changes to metadata defining a UI component such as a workcenter.

Next, at S**210**, a second plurality (i.e., a subset) of the first plurality of software components is determined based on the metadata received at S**205**. Each of the second plurality of software components is associated with metadata received at S**205** which is different from the prior metadata associated therewith. That is, S**210** comprises a determination of those software components whose metadata has been changed.

S**210** also comprises a determination that each of the determined second plurality of software components is associated with elements of the software application. For example, the metadata defining each of the determined second plurality of software components may be associated with authorization policies of the software application (e.g., Role-Based Access Management (RBAM) policies). Accordingly, because this metadata was changed, the authorization policies must be regenerated in view of the changed metadata.

Relevant changes **320** of FIG. **3** represent the second plurality of software components determined at S**210** according to some embodiments. As shown, relevant changes includes not only UI components as discussed above, but also scope and service interface components. Embodiments are not limited to the types of software components mentioned herein.

According to some embodiments, the determination at S**210** is performed by checking an attribute defined by a developer at design time. For example, prior to process **200**, and only if authorization-relevant metadata defining a UI component is changed, a developer fills an attribute (e.g., RBAMChangeTimeStamp) of the metadata with a timestamp indicating the time at which the metadata was changed. Therefore, identification of the software components whose metadata is both changed and relevant to authorization policies merely requires comparing the timestamps of the received metadata with the timestamps of the current metadata defining the software components.

One of the second plurality of software components is identified at S**215** for further processing. Next, at S**220**, it is determined whether the identified software component has been previously considered in the generation of the application elements (e.g., authorization policies) to which its metadata was deemed relevant at S**210**. If not, an indication to consider the identified software component during generation of the application elements is created at S**225**.

FIG. **4**A illustrates table **400** according to some embodiments. Table **400** lists the software components which were previously considered during generation of the application elements. If it is determined at S**220** that the software component identified at S**215** is not listed in table **400**, flow proceeds to S**225** to create an entry including an identifier of the component and its associated timestamp. For example, it is assumed that a component comp**013** is identified at S**215**. Since component comp**013** is not listed in table **400** of FIG. **4**A, a corresponding entry is created as shown in FIG. **4**B.

Flow then proceeds to S**235** to determine whether all of the second plurality of software components have been processed. If not, a next one of the second plurality of software components is identified at S**240** and flow returns to S**220** for the determination described above.

Continuing the present example, it is now assumed that the identified component is comp**007**. Since component comp**007** is listed in table **400**, flow proceeds from S**220** to S**230** to determine whether the timestamp of the received metadata defining component comp**007** is more recent than the timestamp of the previously-considered metadata defining component comp**007**. If so, the entry of table **400** is updated at S**225** to include the timestamp of the metadata of component comp**007** received at S**205**, as shown in FIG. **4**C.

If it is determined at S**230** that the timestamp of the received metadata is not more recent than the timestamp of the previously-considered metadata, flow proceeds to S**235** without modifying table **400**. Flow cycles through S**220**-S**240** as described above until it is determined at S**235** that all of the second plurality of software components have been processed. Then, at S**245**, application elements are generated based on the newly-received metadata of the indicated software components (e.g., the components listed in table **400**). According to some embodiments, table **400** is passed to a sequencer for regeneration of the application elements using known processes.

As described above, the application elements may comprise authorization policies. FIG. **3** depicts the creation of authorization policies **330** based on indicated ones of components **320** according to some embodiments. FIG. **3** also depicts the generation of application elements **340** based on relevant changes **322**.

In this regard, process **200** may execute with respect to more than one type of application elements. That is, relevant changes **320** may include components for which changed metadata was received and for which the changes are relevant to authorization policies **330**, while relevant changes **322** may include components for which changed metadata was received and for which the changes are relevant to UI elements **340**. Therefore, S**215** through S**245** may also be executed with respect to relevant changes **322** to generate UI elements **340** therefrom.

FIG. **5** is a block diagram of apparatus **500** according to some embodiments. Apparatus **500** may comprise a general-purpose computing apparatus and may execute program code to perform any of the functions described herein. Apparatus **500** may comprise an implementation of one or more elements of system **100**. Apparatus **500** may include other unshown elements according to some embodiments.

Apparatus **500** includes processor **510** operatively coupled to communication device **520**, data storage device **530**, one or more input devices **540**, one or more output devices **550** and memory **560**. Communication device **520** may facilitate communication with external devices, such as an external design tool. Input device(s) **540** may comprise, for example, a keyboard, a keypad, a mouse or other pointing device, a microphone, knob or a switch, an infra-red (IR) port, a docking station, and/or a touch screen. Input device(s) **540** may be used, for example, to enter information into apparatus **500**. Output device(s) **550** may comprise, for example, a display (e.g., a display screen) a speaker, and/or a printer.

Data storage device **530** may comprise any appropriate persistent storage device, including combinations of magnetic storage devices (e.g., magnetic tape, hard disk drives and flash memory), optical storage devices, Read Only Memory (ROM) devices, etc., while memory **560** may comprise Random Access Memory (RAM).

Program code **532** of data storage device **530** may be executable by processor **510** to provide functions described herein, including but not limited to process **200**. Embodiments are not limited to execution of these functions by a single apparatus. Metadata **534** may include metadata **150** and/or **160** as described herein. Data storage device **530** may also store data and other program code for providing additional functionality and/or which are necessary for operation thereof, such as device drivers, operating system files, etc.

The foregoing diagrams represent logical architectures for describing processes according to some embodiments, and actual implementations may include more or different components arranged in other manners. Other topologies may be used in conjunction with other embodiments. Moreover, each system described herein may be implemented by any number of devices in communication via any number of other public and/or private networks. Two or more of such computing devices may be located remote from one another and may communicate with one another via any known manner of network(s) and/or a dedicated connection. Each device may comprise any number of hardware and/or software elements suitable to provide the functions described herein as well as any other functions. For example, any computing device used in an implementation of system **100** may include a processor to execute program code such that the computing device operates as described herein.

Elements described herein as communicating with one another are directly or indirectly capable of communicating over any number of different systems for transferring data, including but not limited to shared memory communication, a local area network, a wide area network, a telephone network, a cellular network, a fiber-optic network, a satellite network, an infrared network, a radio frequency network, and any other type of network that may be used to transmit information between devices. Moreover, communication between systems may proceed over any one or more transmission protocols that are or become known, such as Asynchronous Transfer Mode (ATM), Internet Protocol (IP), Hypertext Transfer Protocol (HTTP) and Wireless Application Protocol (WAP).

The embodiments described herein are solely for the purpose of illustration. Those in the art will recognize other embodiments may be practiced with modifications and alterations limited only by the claims.

What is claimed is:

1. A method implemented by a computing system in response to execution of program code by a processor of the computing system, comprising:

executing a software application based on metadata defining data models of a first plurality of software components;

receiving second metadata defining the data models of the first plurality of software components;

determining, based on the second metadata, a second plurality of the first plurality of software components for which the second metadata defining the data models is different from the first metadata defining the data models;

determining, from the second plurality of software components, a third plurality of software components for which the second metadata defining the data models of the third plurality of software components is associated with authorization policies of the software application, where the second plurality of software components comprises one or more other software components for which the second metadata defining the data models of the one or more other software components is not associated with the authorization policies of the software application; and

generating the authorization policies of the software application based on the second metadata defining the data models of the third plurality of software components, and not based on the one or more other software components.

2. A method according to claim **1**, wherein determining the third plurality of software components comprises:

determining that one of the second plurality of software components is associated with the authorization policies of the software application; and

determining that a timestamp of the second metadata associated with the one of the second plurality of software components is later than a timestamp of the first metadata associated with the one of the second plurality of software components.

3. A method according to claim **1**, further comprising:

determining, based on the second metadata, a fourth plurality of the first plurality of software components for which the second metadata defining the data models of the fourth plurality of software components is different from the first metadata defining the data models of the fourth plurality of software components;

determining, from the fourth plurality of software components, a fifth plurality of software components for which the second metadata defining the data models of the fourth plurality of software components is associated with user interface elements of the software application, where the fourth plurality of software components comprises a second one or more other software components for which the second metadata defining the data models

of the second one or more other software components is not associated with the user interface elements of the software application; and

generating the user interface elements of the software application based on the second metadata defining the data models of the fifth plurality of software components, and not based on the second one or more other software components.

4. A non-transitory medium storing processor-executable program code, the program code executable by a device to:

execute a software application based on metadata defining data models of a first plurality of software components;

receive second metadata defining the data models of the first plurality of software components;

determine, based on the second metadata, a second plurality of the first plurality of software components for which the second metadata defining the data models is different from the first metadata defining the data models;

determine, from the second plurality of software components, a third plurality of software components for which the second metadata defining the data models of the third plurality of software components is associated with authorization policies of the software application, where the second plurality of software components comprises one or more other software components for which the second metadata defining the data models of the one or more other software components is not associated with the authorization policies of the software application; and

generate the authorization policies of the software application based on the second metadata defining the data models of the third plurality of software components, and not based on the one or more other software components.

5. A medium according to claim **4**, wherein the program code executable by the device to determine the third plurality of software components comprises program code executable by the device to:

determine that one of the second plurality of software components is associated with the authorization policies of the software application; and

determine that a timestamp of the second metadata associated with the one of the second plurality of software components is later than a timestamp of the first metadata associated with the one of the second plurality of software components.

6. A medium according to claim **4**, further comprising program code executable by the device to:

determine, based on the second metadata, a fourth plurality of the first plurality of software components for which the second metadata defining the data models of the fourth plurality of software components is different from the first metadata defining the data models of the fourth plurality of software components;

determine, from the fourth plurality of software components, a fifth plurality of software components for which the second metadata defining the data models of the fourth plurality of software components is associated with user interface elements of the software application, where the fourth plurality of software components comprises a second one or more other software components for which the second metadata defining the data models of the second one or more other software components is not associated with the user interface elements of the software application; and

generate the user interface elements of the software application based on the second metadata defining the data models of the fifth plurality of software components, and not based on the second one or more other software components.

7. A computing system comprising:

a memory system storing processor-executable program code; and

a processor to execute the processor-executable program code in order to cause the computing device to:

execute a software application based on metadata defining data models of a first plurality of software components;

receive second metadata defining the data models of the first plurality of software components;

determine, based on the second metadata, a second plurality of the first plurality of software components for which the second metadata defining the data models is different from the first metadata defining the data models;

determine, from the second plurality of software components, a third plurality of software components for which the second metadata defining the data models of the third plurality of software components is associated with authorization policies of the software application, where the second plurality of software components comprises one or more other software components for which the second metadata defining the data models of the one or more other software components is not associated with the authorization policies of the software application; and

generate the authorization policies of the software application based on the second metadata defining the data models of the third plurality of software components, and not based on the one or more other software components.

8. A system according to claim **7**, wherein determination of the third plurality of software components comprises:

determination that one of the second plurality of software components is associated with the authorization policies of the software application; and

determination that a timestamp of the second metadata associated with the one of the second plurality of software components is later than a timestamp of the first metadata associated with the one of the second plurality of software components.

9. A system according to claim **7**, the processor further to execute the processor-executable program code in order to cause the computing device to:

determine, based on the second metadata, a fourth plurality of the first plurality of software components for which the second metadata defining the data models is different from the first metadata;

determine, from the fourth plurality of software components, a fifth plurality of software components for which the second metadata defining the data models of the fourth plurality of software components is associated with user interface elements of the software application, where the fourth plurality of software components comprises a second one or more other software components for which the second metadata defining the data models of the second one or more other software components is not associated with the user interface elements of the software application; and

generate the user interface elements of the software application based on the second metadata defining the data models of the fifth plurality of software components, and not based on the second one or more other software components.

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